TITAN'S UNIQUE ATTRACTION: IT IS AN IDEAL DESTINATION FOR HUMANS

There are so many opportunities for scientific exploration in the Solar System that it may be hard to choose between them. But Titan has one quality that sets it apart: it is uniquely suitable for human visitors.

One of the reasons for robotic exploration of Mars is that humans will arrive in due course. An identical justification applies to the robotic exploration of Titan. For humans to reach Titan there needs to be a significant advance in propulsion. So human visitors probably will arrive long after they reach Mars. But just as the time scale for human visitors is longer, so too is the time-scale for robotic exploration.

Even though it is not possible for humans to visit yet, as robotic exploration shows that Titan is fascinating, propulsion research to reach Titan is more justified.

The following paper suggests that Titan is by far the most hospitable place for humans anywhere in the solar system.

This paper is sent at my sole initiative. By way of endorsement it has been peer reviewed and will be published in October in "Aviation, Space, and Environmental Medicine", the World's leading aviation and space medicine journal.

Julian Nott

President Nott Technology LLC Santa Barbara California USA

Jahan Nort

September 15 2009

Titan: A Distant But Enticing Destination for Human Visitors

Julian Nott

NOTT J. Titan: a distant but enticing destination for human visitors. Aviat Space Environ Med 2009; 89:1–2.

Until recently, very little was known about Saturn's largest satellite, Titan. But that has changed dramatically since the Cassini spacecraft started orbiting in the Saturn system in 2004. Larger than Mercury and with a dense atmosphere, Titan has many of the characteristics of a planet. Indeed, many scientists now see it as the most interesting place in the Solar System for robotic exploration, with many unique features and even the possibility of exotic forms of life. This paper points out that Titan is also a potential destination for humans. With its predominantly nitrogen atmosphere, moderate gravity, and available water and oxygen, it also appears that, once it becomes possible to travel there, it will prove to be much more hospitable for human visitors than any other destination in the Solar System.

Keywords: exploration, space travel.

UNTIL RECENTLY, VERY little was known about Saturn's largest satellite, Titan. A billion miles from Earth, covered by cloud and "merely a moon," it attracted limited interest. But that has changed dramatically since the Cassini spacecraft started regular flybys in 2004 and the Huygens probe parachuted to its surface in 2005 (2).

Although it orbits Saturn, Titan is 10 times heavier than Pluto and larger than Mercury. While very different from Earth, it has emerged as the most earthlike body in the Solar System. Barometric pressure at the surface is 1.45 ATA and its atmosphere is composed mostly of N₂. It also has a cycle of evaporation, clouds, and rainfall—except that methane replaces water in that cycle (3). Titan has weather and surface erosion as well as lakes and seas that probably consist of methane and longer-chain hydrocarbons; one sea, Kraken Mare, is the size of the Caspian.

The methane oceans may have existed for hundreds of millions of years and may have or currently support chemical reactions unlike anything previously imagined. If it is discovered that some form of life exists on Titan, not based around DNA but on an entirely different chemistry, it would revolutionize our thinking about the nature of life. In addition, if life has appeared spontaneously twice in our Solar System, that would strongly suggest that life will have developed in many times and places throughout the known universe (4). In addition to the methane cycle, Titan has below its surface an ocean of liquid water that might harbor somewhat more conventional life. Because of these and other factors, many scientists now feel Titan is the most interesting place in the solar system for exploration (6) and NASA and European agencies are planning robotic missions.

Travel to Titan has been widely discussed in science fiction (for examples, search Wikipedia with the phrase "Titan in fiction"). Nevertheless, it is easy to understand why the concept is only now attracting serious attention. At present, a Mars landing is decades away, and the Planetary Society's roadmap for human exploration of the Solar System does not address travel beyond Mars (1). But let us assume for the sake of discussion that an improved propulsion system will someday allow humans to land on Titan. What will they find?

Human visitors, hereafter called Titannauts, will find Titan far more hospitable than any site on the Moon, Mars, or asteroids. Unlike those bodies, Titan will provide reasonable atmospheric pressure and radiation shielding as well as available water and O₂, thereby greatly simplifying problems related to life support and reducing the need to transport consumable supplies.

- Titan's surface pressure of 1.45 ATA will eliminate the need for a costly, cumbersome pressure suit with its complex logistic tail and mortal risk if the pressure envelope is breached.
- Titan's atmosphere has 10 times more mass per unit of surface area than Earth's and will, therefore, shield visitors from the solar and cosmic radiation that is a problem on other bodies. In contrast, housing on Mars may need to be buried beneath the surface for radiation protection.
- While Titannauts will need to bring their own initial supplies of water and O₂, water-ice will be available and can be used as a source of O₂ by means of electrolysis.
- \bullet The O_2 could then be supplied to the Titannaut using a high-quality mask or simple hood and a scuba-like rebreather system.

Titan's gravity is only 14% of Earth's, so equipment weight would be greatly reduced.

Titan's surface temperature is -179° C, so it will be essential to keep both Titannauts and equipment warm inside a cocoon of insulation. Nevertheless, the temperature difference between the skin and the environment is only about twice that seen in the coldest terrestrial environments and, on what is currently known and inferred, there is little wind on Titan. Furthermore, gas conductivity falls sharply with temperature, so that simple trapped-gas insulation will work better than on Earth.

DOI: 10.3357/ASEM.2596.2009

From Nott Technology, LLC, Santa Barbara, CA.

This manuscript was received for review in June 2009. It was accepted for publication in August 2009.

Address reprint requests to: Julian Nott, nott@nott.com.

Reprint & Copyright © by the Aerospace Medical Association, Alexandria, VA.



Fig. 1. Left: Apollo footprints on the Moon 40 yr ago. Right: Huygens picture of Titan to the same scale. Will there be footprints here 40 yr from now?

With a surface area of 2 m^2 and insulation 7.5 cm thick, heat loss should be about 150 W, which can be generated by light activity. Batteries to heat a visor and gloves would weigh little on Titan.

Titan's global atmospheric composition has yet to be completely characterized, but what Huygens detected was not highly toxic (2). For instance, there was 0.2 ppm of hydrogen cyanide, far below the OSHA limit for continuous exposure. However, the long-term effects of inhaling methane and other hydrocarbons are unknown, as is also true for the heteropolymer molecules (tholins) formed by UV irradiation of simple organic compounds such as methane in the upper atmosphere and floating everywhere in the atmosphere. Mask or hood safety

pressure will, therefore, be advisable, but a temporary inboard leak would probably be harmless.

For simplicity, a Titan habitat would likely operate at ambient pressure, so that returning to a spacecraft with an Earth-normal cabin would involve mild decompression without any requirement for washout of N_2 (5). It therefore seems that Titannauts could live in a simple habitat above ground and walk on the surface using clothing and equipment not much different from what could be purchased today from a sporting goods store. Despite the unusual colors and lack of vegetation, Titan's landscapes, mountains, and clouds look hauntingly like Earth (7), and no doubt the same applies to sunsets and views of lakes or seas. Visitors fully mobile in "super ski suits" with agreeable scenery should find Titan psychologically much more comfortable than any other destination in the solar system.

Travel to Titan will require much more effective propulsion systems than those now available. In the late 19th century, when Robert Goddard was in his teens, the explosion of knowledge about Mars (and perhaps the writings of H. G. Wells) inspired him to invent rockets for space travel. Perhaps the current flood of discoveries about Titan is even now inspiring a "Goddard" of antimatter propulsion. Neil Armstrong stepped onto the surface of the Moon 40 yr ago (Fig. 1). Perhaps 40 yr from now a Titannaut with much simpler equipment will step onto a surface a billion miles from Earth and simply go for a stroll.

ACKNOWLEDGMENTS

Special thanks to Professor Jonathan Lunine, University of Arizona, Dr Tom Spilker, NASA Jet Propulsion Laboratory, and Professor Don Barthelmess, Santa Barbara City College, CA.

Author and affiliation: Julian Nott, B.S., M.S., President, Nott Technology, LLC, Santa Barbara, CA.

REFERENCES

- Bell J, Friedman L, Hubbard GS, Huntress W, McKay C, et al. Beyond the Moon, a new roadmap for human space exploration in the 21st century. Pasadena, CA: The Planetary Society; November 2008.
- Lebreton JP, Witasse O, Sollazzo C, Blancquaert T, Couzin P, et al. An overview of the descent and landing of the Huygens probe on Titan, and seven related papers. Nature 2005; 438:758–64.
- 3. Lunine JI, Atreya SK. The methane cycle on Titan. Nature Geoscience 2008; 1:159–64.
- Lunine JI. Saturn's Titan: A strict test for life's cosmic ubiquity. Proc Am Philos Soc 2009; (in press).
- 5. NOAA Diving Manual, 4th ed. Flagstaff, AZ: Best Publishing Co.; 2001:17–20.
- 6. Reh K, Magner T, Matson D, Coustenis A, Lunine J, et al. Titan Saturn system mission study: final report. Washington, DC: NASA and The European Space Agency; January 2009.
- Titan images. Retreived from: http://saturn.jpl.nasa.gov/photos http://Saturn.jpl.nasa.gov.



Q1